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The Food of the Megrim

BENNET B. RAE, M.A., B.Sc., Ph.D., F.R.S.E.

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By BENNET B. RAE, M.A., B.Sc., Ph.D., F.R.S.E.
Marine Laboratory, Aberdeen
March, 1963

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The Food of the Megrim

INTRODUCTION

The investigation described in this paper was commenced in the late 1930s as part of a broader rogramme of research on flat-fishes which had to be abandoned on the outbreak of war in 1939. Al- ıough work was resumed on the more valuable species such as plaice, lemon sole and halibut after the ar, the programme of research on the megrim, *Lepidorhombus whiff-iagonis* (Walbaum), was discontinued, ecause of its relative unimportance, to allow attention to be given to more urgent problems. Neverthe- ss, as circumstances permitted, every opportunity was taken to collect material for a continuation of ıe study of its food. This, together with the localised distribution of the megrim in fairly deep water and ıe consequent difficulties in collecting sufficient material, accounts for the prolongation of the investi- ıation over the period 1938-1960.

During the later years of the investigation most of the work of examination of the stomachs and entification of their contents was carried out by Mr. S. D. E. Devlin or by assistants and students orking under his supervision.

COLLECTION AND TREATMENT OF MATERIAL

All the material used in this study was collected by Scottish research vessels using an otter trawl with small-mesh cover on the codend to retain the small fish. The megrim were divided into 10 cm size- oups. With the exception of some examined in the fresh state by the author on cruises of which he was

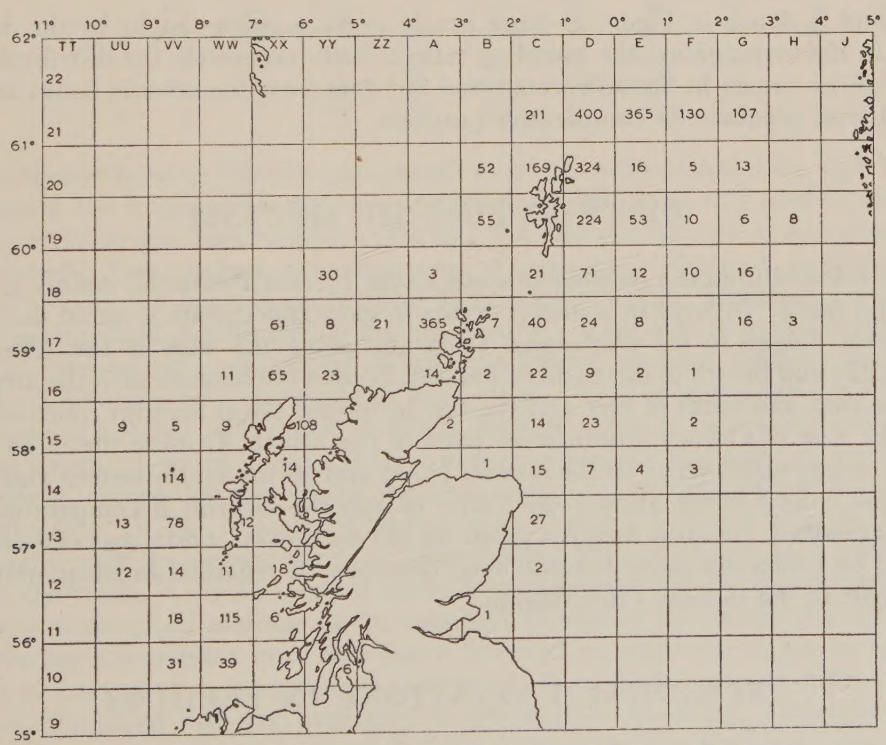

Fig. 1 Sampling of megrim for food analysis, 1938-1960

personally in charge, all the stomachs were removed from the fish immediately they were caught and preserved in 3% formalin. The examination of the collections was carried out in the laboratory.

Observations made during the examination included the recording of the numbers of stomachs containing food and the numbers which were empty, and the measurement of the volume of food in each stomach by the method of water displacement. The volume of each main type of food, crustacean, molluscan, fish etc. was then measured in each sample, and finally the food was identified in more detail, down to the genus and, where possible, without excessive painstaking, to the species.

In all, more than 4,400 stomachs were examined. Nearly 2,500 were obtained from the North Sea (south of 61°30′N and east of 3°W), more than 1,200 from the north (west of 3°W) and west of Scotland, nearly 200 from the oceanic banks, including Rockall, Bill Bailey's and Faroe Banks, and over 400 from Icelandic grounds.

Figure 1 gives the numbers of stomachs collected in the North Sea and on the west of Scotland in each statistical rectangle, as determined by the intersection of the lines of longitude and latitude. The

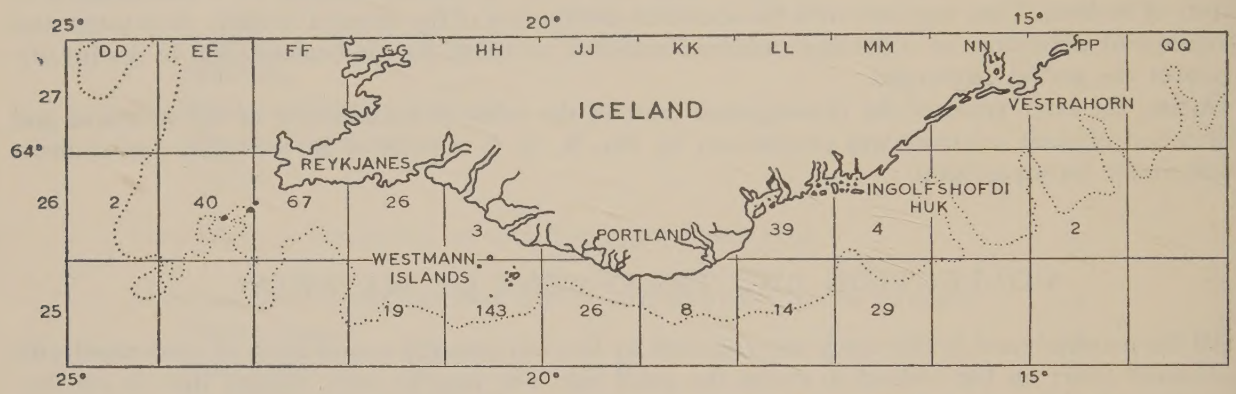

Fig. 2 Sampling of megrim for food analysis at Iceland.

sampling at Iceland is shown in Figure 2. Since nearly every megrim caught by the Scottish research vessels was used in the investigation the sampling reflects fairly accurately the distribution, density and size-composition of the species in Scottish waters and the data from the oceanic banks and Iceland may be regarded as at least adequate for comparative purposes.

DISTRIBUTION OF MEGRIM

The megrim is found from the Norwegian coast to the Iberian Peninsula, mainly in depths around the 100 fm (183 m) mark. In Scottish waters it occurs in some concentration round the Shetlands, eastwards from Muckle Flugga to the Norwegian Deep and along the edge of the Atlantic Shelf from Shetland to St. Kilda and thence to the north of Ireland. Beyond the Scottish area the megrim is plentiful on grounds to the west and south of Eire and the Bay of Biscay. Local Scottish concentrations occur in Noup Deep to the west of Orkney and in some parts of the Minch. Outside the main European concentration, independent stocks occur on the oceanic banks and off the south-western and southern coasts of Iceland. On the coastal banks around the Faroe Islands the megrim is comparatively scarce, and according to Saemundsson (1949) it does not occur on the north-west, north and east coasts of Iceland.

The material on which this paper is based may, therefore, be regarded as adequately representative of the northern part of the megrim's distribution.

SEASONAL VARIATIONS IN FEEDING

Early in this investigation it was found that throughout the year a high proportion of the stomachs

contained no food. This is in sharp contrast to the lemon sole, in which empty stomachs are rare during the main feeding season (Rae, 1956). At first it was thought that some of the contents might have been lost during the removal of the stomachs from the fish, but this possibility was eliminated by adopting a more reliable technique at sea. The large mouth, the nature of the stomach and the type of organisms eaten suggested, however, that many of the megrims regurgitated their food when caught in a trawl. This is possible, just as in some other fish, but many stomachs appear to retain all or the greater part of their contents so that regurgitation is very far from general. At the same time sufficient food is usually left to permit a satisfactory qualitative analysis of the diet of the species. Moreover no evidence was found to suggest that regurgitation was more frequent at one time of the year than at another or in one region than in another. Accordingly, in order to study seasonal differences in the feeding, the data from all areas were combined.

Proportions of Stomachs Containing Food

Table I gives the numbers of stomachs examined from fish in the various 10cm size-groups, together

TABLE I

Proportions of Megrim Feeding throughout the Year

All Areas, 1938-1960

No. of Fish Examined (N), Percentage Feeding (F)

Size-group in cm	11-20		21-30		31-40		41-50		51-60		All sizes	
	N	F	N	F	N	F	N	F	N	F	N	F
January	—	—	—	—	6	17	5	60	—	—	11	36
February	11	55	67	34	70	51	27	30	6	67	181	43
March	14	64	81	44	128	65	39	69	6	67	268	59
April	40	40	103	49	115	42	46	57	8	62	312	46
May	5	40	65	45	95	44	56	55	10	80	231	48
June	78	86	295	75	236	51	110	55	8	50	727	65
July	52	75	187	79	189	74	91	51	19	68	538	72
August	65	97	203	81	246	69	89	62	9	78	612	75
September	77	78	216	81	166	78	70	71	25	32	554	76
October	16	25	89	39	149	38	103	35	10	40	367	37
November	15	60	112	52	191	58	76	55	9	67	403	56
December	7	71	62	68	64	52	39	51	—	—	172	58

with the percentages containing food, in each month over the entire period from 1938 to 1960. In order to eliminate some of the irregularities due to inadequate sampling in certain months, the five size-groups were reduced to three by the combination of the first two and the last two as size-groups 11-30 cm and 41-60 cm respectively. The resultant percentages are represented in Figure 3, in which the percentages of feeding fish of all sizes (see last column of Table I) are also indicated. The graph for all sizes of megrim shows that feeding increases rapidly during the first quarter of the year. A recession then occurs in April and May and is followed by a resumption of intensive feeding in June. Feeding continues to increase throughout July and August to a maximum in September. The numbers of feeding fish of all sizes then fall away suddenly in October, and just as suddenly increase again in November and December.

The graphs for the 11-30 cm and 31-40 cm size-groups resemble the composite graph for all sizes in nearly every respect, except that the smaller fish show only a very slight decline in the numbers feeding in April and May (Fig. 3). The intensity of feeding of the larger (41-60 cm) megrim, however, reveals a somewhat different cycle throughout the year. Disregarding the apparently high proportion of feeding fish in January, the result, it would seem, of inadequate sampling, the graph representing the 41-60 cm fish shows a very pronounced increase in the numbers of feeding fish in the first quarter of the year. This increase reaches a maximum in March and is followed by a sudden decline in April. This decline, however, is not so marked as in the 31-40 cm size-group, since more than half of the large fish evidently continue to feed, compared with just over 40% in the smaller size-group. Throughout the late spring, summer, and early autumn, the proportion of large megrim feeding fluctuates between 54 and 63%.

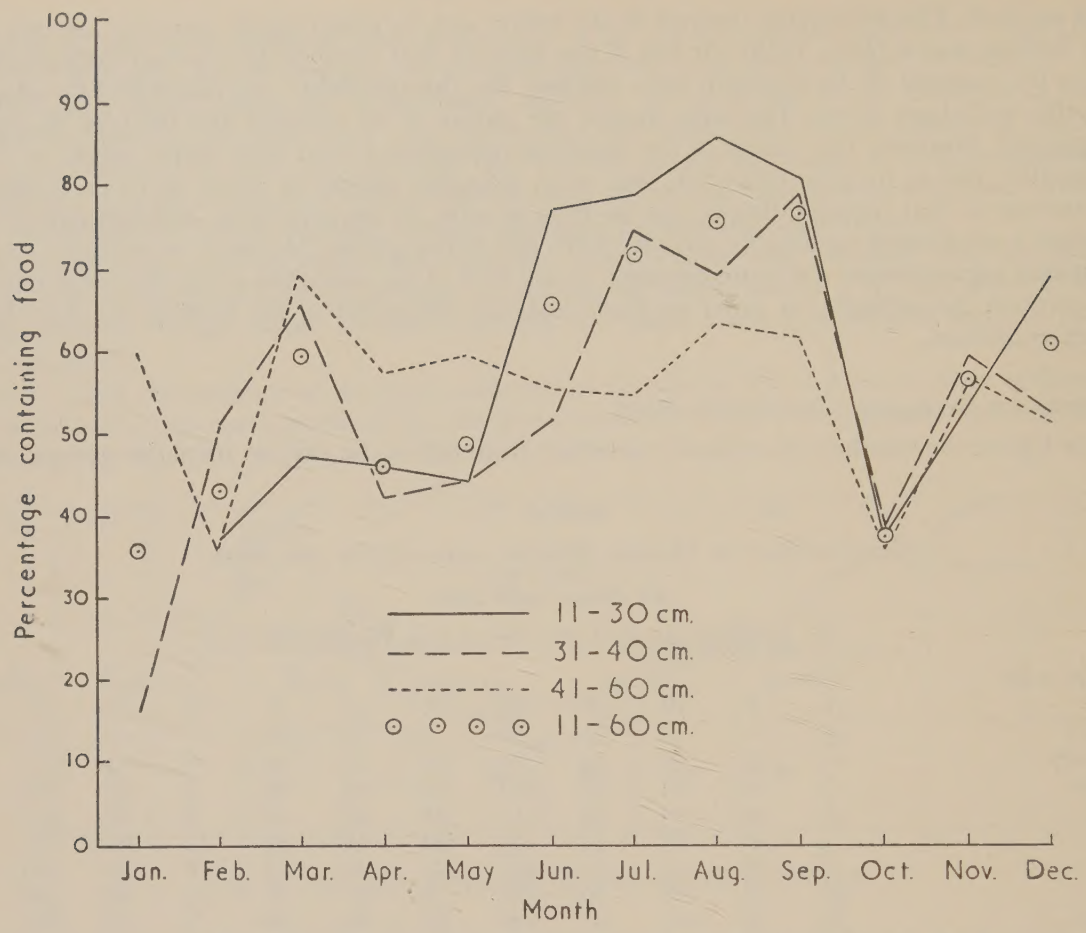

Fig. 3 Seasonal feeding of megrim; percentages of stomachs containing food.

Although feeding in this group rises to another peak in August the increase is in no way comparable with the maximum attained by the small- and medium-sized fish in the same period, nor does it even reach its own spring maximum. After exhibiting these differences the large fish revert to the pattern of feeding of the smaller fish in October when the proportion containing food declines suddenly to a mere 35%. In November and December large megrim, like the smaller fish, again begin to feed more heavily.

Volumes of Food in the Stomachs

The seasonal intensity of feeding of the megrim may also be studied by considering the quantities of food found in the stomachs throughout the year. For comparative purposes the total volumes of food found in all the stomachs examined in each size-group have been used to estimate the volumes per 100 stomachs (Table II). In order to render these results more conveniently comparable the five size-groups have again been reduced to three and the resultant values plotted in Figure 4.

The 11-30 cm size-group shows an increase in the quantity of food taken from February to March. This is followed by a decline in April and, thereafter, by a steady increase in the quantities consumed throughout the summer to a maximum in September. In October the quantity of food eaten falls sharply after which it continues at about the same level to the end of the year.

The 31-40 cm size-group exhibits a sharp rise in feeding from January to March, and a marked decline in April which, despite a slight recovery in May, continues into June. Feeding then increases rapidly to a maximum in July and remains fairly high, though variable, throughout August and September. After a sharp decline in October feeding improves again in November.

The 41-60 cm fish, as in dealing with the proportions containing food, again reveal a different

TABLE II

THE INTENSITY OF FEEDING OF MEGRIM THROUGHOUT THE YEAR

ALL AREAS, 1938-1960

No. of Stomachs Examined = N Calculated Volume of Food per 100 Stomachs in cc = V

ize-group in cm	11-20		21-30		31-40		41-50		51-60	
	N	V	N	V	N	V	N	V	N	V
January	—	—	—	—	6	67	5	180	—	—
February	11	27	67	38	69	167	25	383	6	2083
March	14	18	81	73	121	240	38	914	6	1668
April	41	13	104	41	114	146	46	941	8	2467
May	5	30	54	57	84	176	48	416	10	1451
June	79	36	279	63	230	129	110	444	8	384
July	52	28	184	98	173	403	74	777	19	1215
August	61	31	201	86	242	195	86	651	9	970
September	73	38	215	200	168	276	65	518	25	187
October	10	3	32	88	42	149	17	345	3	1153
November	15	27	109	81	186	208	77	426	9	1417
December	7	26	62	73	64	153	39	322	—	—

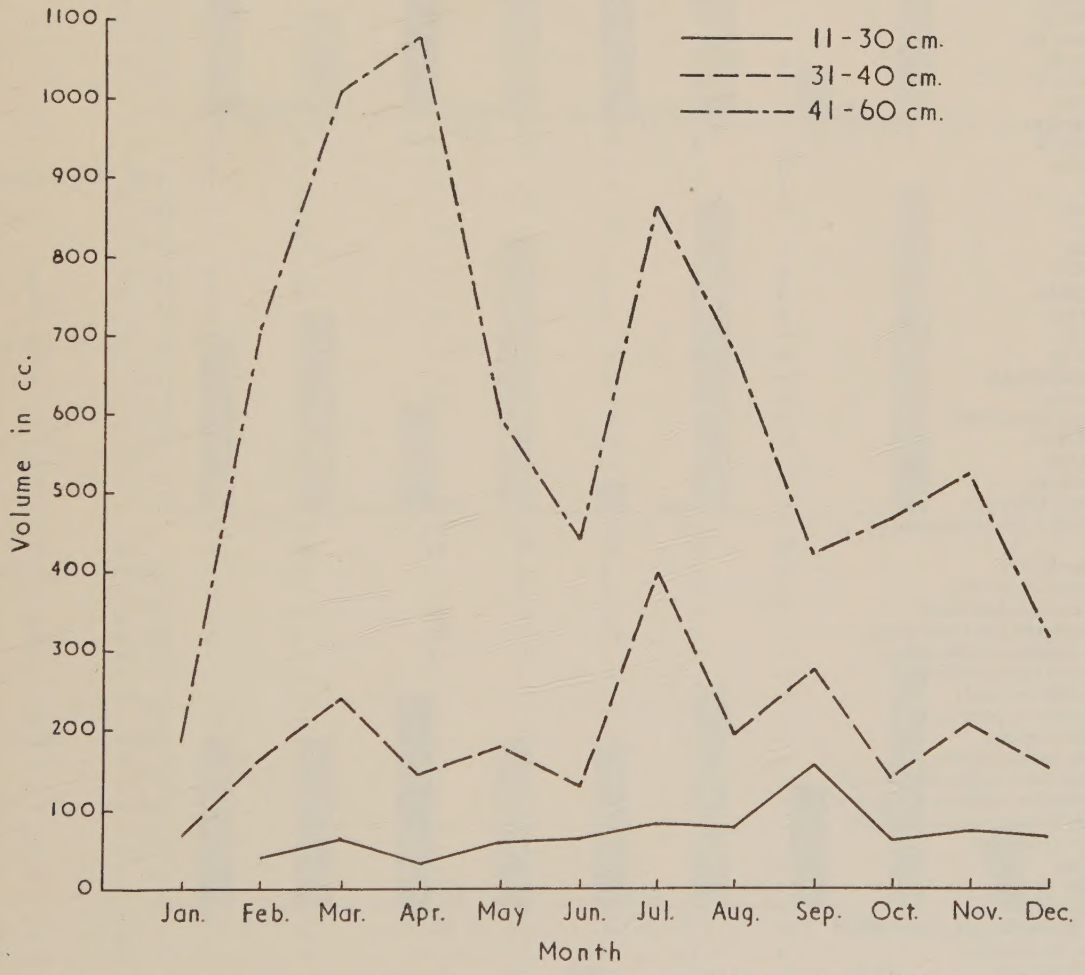

Fig. 4 Seasonal feeding of megrim as represented by the volume of food per 100 stomachs.

pattern of feeding from the smaller fish. After a sharp increase to a maximum in March and April, feeding declines sharply in May and June. This is followed by another increase to a secondary maximum in July, after which the quantity of food in the stomachs falls away throughout August to a low level in September. A slight increase in October and November is followed by a further decline in December. Figure 4 clearly suggests that the intensity of feeding of large megrim is highest in March and April which is in contrast to that of the smaller fish in which it is highest during the summer and autumn.

TABLE III

THE FOOD OF MEGRIM IN SCOTTISH WATERS
FREQUENCY OF OCCURRENCE OF THE VARIOUS TYPES EXPRESSED AS PERCENTAGES OF THE NUMBER OF STOMACHS CONTAINING RECOGNISABLE FOOD, 1938-1960

Region	NORTH SEA (S. of 61° 30′ N & E. of 3° W)					NORTH & WEST OF SCOTLAND				
Size-group in cm	11-20	21-30	31-40	41-50	51-60	11-20	21-30	31-40	41-50	51-60
No. of stomachs examined	271	910	930	353	39	70	388	507	268	14
No. with recognisable food	191	579	524	176	18	51	273	282	138	5
Percentage feeding on:										
CRUSTACEA	85	62	30	16	6	90	74	45	17	—
Decapoda (unidentified)	13	10	7	5	—	22	10	6	5	—
Crangon sp.	34	27	11	5	—	53	55	28	4	—
Pandalus sp.	21	15	6	2	—	6	11	5	4	—
Hippolyte sp.	—	—	—	1	—	—	—	—	—	—
Pontophilus sp.	1	—	1	1	—	2	+	3	—	—
Sclerocrangon sp.	—	+	—	—	—	—	—	—	1	—
Nika edulis	—	1	1	—	—	—	—	+	—	—
Nephrops norvegicus	—	—	—	—	—	—	—	+	—	—
Galathea sp.	2	1	+	—	6	—	3	+	1	—
Munida sp.	—	3	1	1	—	—	1	1	1	—
Calocaris sp.	—	+	—	—	—	—	+	1	1	—
Eupagurus sp.	—	+	—	—	—	—	—	—	—	—
Portunus sp.	3	2	2	1	—	2	3	4	—	—
Atelecyclus sp.	—	2	+	—	—	—	2	—	—	—
Ebalia sp.	—	—	+	1	—	—	—	—	—	—
Gonoplax sp.	—	—	—	—	—	—	+	—	—	—
Euphausiacea	5	2	1	—	—	2	3	+	—	—
Amphipoda	5	1	—	—	—	2	2	+	—	—
Isopoda	1	1	+	—	—	2	1	2	1	—
Mysidacea	10	3	1	—	—	6	2	—	—	—
Cumacea	—	—	—	—	—	4	—	—	—	—
Copepoda	1	—	—	—	—	—	—	—	—	—
MOLLUSCA	3	5	6	5	—	4	3	3	5	—
Cephalopoda	3	4	5	5	—	4	2	2	5	—
Sepiola sp.	2	2	3	1	—	—	+	+	—	—
Rossia sp.	—	+	—	—	—	—	—	—	1	—
Gonatus sp.	—	—	+	—	—	—	—	—	—	—
Lamellibranchiata	—	+	—	—	—	—	—	—	—	—
Gasteropoda	—	+	—	—	—	—	—	—	—	—
Scaphoda (Dentalium)	—	+	+	—	—	—	1	—	—	—
POLYCHAETA	—	+	+	—	—	4	3	+	—	—
Aphroditidae	—	—	—	—	—	4	2	+	—	—
Nephthydidae	—	—	—	—	—	—	+	—	—	—
Serpulidae (Ditrupa)	—	—	+	—	—	—	—	—	—	—
ECHINOIDEA (Echinocyamus)	1	—	—	—	—	—	—	—	—	—
PISCES	35	56	79	86	94	31	42	66	87	100
Post-larval fish	10	7	4	1	—	—	2	1	—	—
Ammodytes (Sandeels)	4	6	8	6	—	—	2	1	—	—
Gadus sp. (unidentified)	—	2	5	11	39	—	3	9	14	—
Gadus esmarkii (Norway pout)	1	7	10	15	22	2	3	8	25	20
Gadus aeglefinus (haddock)	—	—	1	—	6	—	—	—	—	—
Gadus merlangus (whiting)	—	—	+	1	—	—	—	—	—	—
Gadus callarias (cod)	—	—	—	1	—	—	—	—	—	—
Gadus minutus (poor cod)	—	+	+	—	—	—	+	—	—	—
Gadiculus argenteus	—	—	+	—	—	—	—	—	—	—
Flatfish (unidentified)	2	+	1	1	—	—	+	+	—	—
Hippoglossoides platessoides (l.r.dab)	2	1	1	1	—	—	—	1	—	—
Lepidorhombus whiff-iagonis (megrim)	1	+	—	—	—	—	—	—	—	—
Limanda limanda (common dab)	—	—	—	—	—	—	+	—	—	—
Onos sp. (rockling)	—	—	—	—	—	—	—	—	1	20
Gobius sp.	2	2	2	1	—	2	+	1	—	—
Argentina sp.	1	1	2	5	6	—	—	+	1	—
Callionymus sp.	1	1	1	—	—	—	2	2	1	—
Trigla gurnardus (grey gurnard)	—	—	—	—	—	—	—	+	—	—
Sebastes sp. (redfish)	1	1	1	1	—	—	—	—	—	—
Fierasfer dentatus	—	—	+	1	—	—	—	—	—	—
Agonus cataphractus	1	+	—	—	—	—	—	—	—	—
Clupea harengus (herring)	—	+	+	1	—	—	—	—	—	—

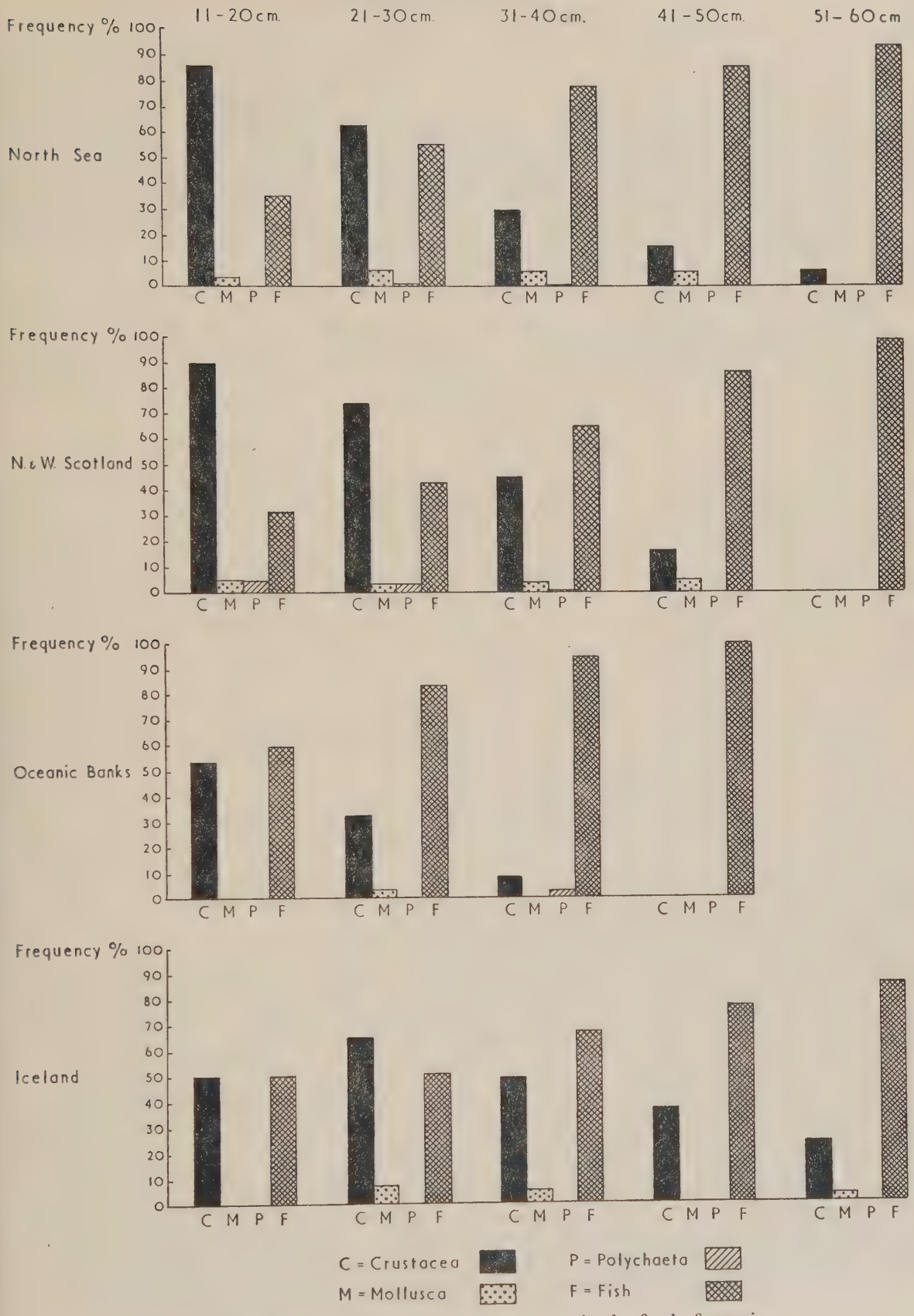

Fig. 5 Frequency of occurrence of main types in the food of megrim.

COMPOSITION OF THE STOMACH CONTENTS

The identification of the stomach contents of the megrim presented, on the whole, little or no diffi culty. A macroscopic examination with the help of a magnifying glass generally sufficed to identify th various constituents. Although digestion appears to proceed rapidly in the megrim, identification of th food is facilitated by the comparatively large size of most of the individual animals eaten and also, t some extent, by the relatively few main types composing the food. Even when the stomach contents hav consisted solely of animal remains it has at least been possible to recognise the food as fish, crustacea mollusc etc. Consequently the unrecognisable food in the stomachs has rarely amounted to as much a 1% of the total volume in any size-group or in any region. Along with the food, sea-rounded pebble including small pieces of coal, were found in about 1% of the stomachs.

The types of food identified in the stomach contents of the megrim and the frequencies with whic the individual organisms appear in the food are represented as percentages of the total number o stomachs containing recognisable material in Tables III and IV. The frequencies of occurrence of th principal types are also illustrated in Figure 5. Lists of the individual genera and species identifie together with the localities in which they were eaten, are given in the appendix to this paper.

North Sea

Table III shows that the food of megrim in the North Sea consists principally of crustaceans and fish Small numbers of molluscs and negligible quantities of polychaetes and echinoderms are also eaten Indeed, the polychaetes are frequently represented merely by traces, and echinoderms, in the form of th small *Echinocyamus pusillus*, have been found in the stomachs of only two fish on one occasion.

Table III also reveals a marked change in the composition of the food of megrim with the growth o the fish. Megrim of less than 11 cm are rarely caught by Scottish research vessels. In this respect th megrim resembles the lemon sole (Rae, 1939) in which it was concluded that the escape of the smalle bottom-living sizes was due to various reasons, including the ability of the small fish to penetrate th meshes of both the codend and its small-mesh cover, the greater depths at which these fish live com pared with some other species of flatfish, and the nature of the sea bottom on which they live. The reasons may also apply to the megrim, but whatever the explanation may be, only six small megrim 6-10 cm were examined in the course of this investigation. All six were feeding, and all entirely on crust ceans; two had eaten young *Crangon* and one young *Pandalus*.

Crustaceans also provide the bulk of the food of the 11-20 cm size-group. As Table III shows, nata decapods such as *Crangon* and *Pandalus* appear more frequently in the stomachs than any other individu food type. Smaller crustaceans such as euphausids, amphipods and mysids would appear to be eate fairly frequently by fish in the lower half of this size-range so that it seems likely that these types for an appreciable part of the food of youngest megrim from their post-larval stage up to a length of 15 cm Megrim of 11-20 cm also eat fish, chiefly post-larval forms.

Throughout the other size-groups the proportions of crustaceans eaten decline steadily to a minimu in the largest fish of 51-60 cm. Natant decapods continue to be the crustaceans most commonly eate although, as may be expected, the frequencies with which they are taken decline roughly in proportio to those of the crustaceans as a whole. Small quantities of reptant decapods are also eaten, especially b medium-sized fish. It is worth noting too that euphausids, mysids and other small forms disappear fro the food of the two larger size-groups.

Concurrently with this declining interest in crustaceans megrim eat more fish. This rises to a max mum of over 90% in fish of 51-60 cm. Furthermore, the early interest in post-larval forms gradual disappears and larger numbers of juvenile and, later, adult fish are eaten. While the different sizes sandeels form an important item of food to megrim of all size-groups, young and small gadoids clear represent the principal food type of the bigger fish. *Gadus esmarkii* for example, eaten by 1% of th 11-20 cm megrim, increases in importance throughout the other size-groups to a maximum of 22% i fish of 51-60 cm. Undoubtedly this proportion would be higher if one could allocate the unidentified fis and the unidentified gadoids (in 39% of megrim of 51-60 cm) to their constituent species.

Megrim also prey on flatfishes, mainly post-larval forms, including the megrim itself, and on variou

species of little or no direct economic importance. Of the latter the argentines are eaten more frequently as the megrim grow bigger. Molluscs, represented chiefly by cephalopods, among which one genus, *Sepiola,* predominates, are eaten by megrim of all sizes.

North and West of Scotland

The food of the megrim on grounds to the north and west of Scotland closely resembles that of the North Sea fish (Table III). Such differences as occur are more in the proportions of the various types rather than in any specific difference in the individual organisms. Thus more *Crangon* but fewer *Pandalus* are eaten on northern and western grounds; cephalopods are taken less frequently by all sizes but at the same time polychaetes are eaten more often by the smaller megrim. As in the North Sea the principal fish preyed upon by all sizes of megrim, and especially by the bigger fish, is the Norway pout, *Gadus esmarkii.*

The Oceanic Banks

Although the numbers of megrim examined from the oceanic banks are perhaps too small to allow

TABLE IV

The Food of Megrim on the Oceanic Banks and at Iceland
Frequency of Occurrence of the Various Types Expressed as Percentages of the Number of Stomachs Containing Recognisable Food.

Region	Oceanic Banks				Iceland				
Size-group in cm	11-20	21-30	31-40	41-50	11-20	21-30	31-40	41-50	51-60
No. of stomachs examined	18	105	62	8	15	75	155	120	55
No. with recognisable food	15	80	51	5	10	52	109	83	40
Percentage feeding on:									
CRUSTACEA	53	33	8	—	50	65	50	37	23
Decapoda (unidentified)	20	16	6	—	10	27	17	12	13
Crangon sp.	13	8	—	—	10	17	14	6	—
Pandalus sp.	20	9	4	—	—	23	15	16	5
Hippolyte sp.	—	—	—	—	—	—	1	—	—
Nephrops norvegicus	—	—	—	—	—	2	4	8	8
Munida sp.	—	—	—	—	—	2	1	—	—
Calocaris sp.	—	—	—	—	—	—	—	1	—
Portunus sp.	—	—	—	—	—	—	—	—	3
Euphausiacea	—	3	—	—	—	8	14	—	—
Amphipoda	—	—	—	—	10	—	1	—	—
Isopoda	—	—	—	—	—	—	1	—	—
Mysidacea	13	—	—	—	30	2	—	—	—
Cirripedia	—	1	—	—	—	—	—	—	—
MOLLUSCA	—	3	—	—	—	6	5	—	3
Cephalopoda	—	3	—	—	—	6	5	—	3
Sepiola sp.	—	—	—	—	—	—	1	—	—
POLYCHAETA	—	—	2	—	—	—	—	—	—
PISCES	60	83	94	100	50	50	67	77	85
Post-larval fish	7	3	—	—	30	2	6	—	3
Ammodytes sp. (sandeels)	7	29	33	—	—	4	13	13	13
Gadus sp.	7	11	25	100	—	10	4	12	18
Gadus esmarkii (Norway pout)	7	6	6	20	—	4	2	5	5
Gadus aeglefinus (haddock)	—	—	12	80	—	2	—	—	—
Gadus merlangus (whiting)	—	—	—	—	—	—	1	1	—
Gadus poutassou	—	1	2	—	—	—	—	—	—
Onos tricirratus (3 bearded rockling)	—	—	—	—	—	—	—	—	3
Flatfish (unidentified)	—	—	—	—	20	2	6	1	13
Hippoglossoides platessoides (l.r.dab)	—	—	—	—	20	4	1	4	5
Lepidorhombus whiff-iagonis (megrim)	—	—	—	—	10	—	—	—	—
Argentina sp.	—	1	—	—	—	—	—	1	3
Fierasfer dentatus	—	—	—	—	—	—	—	—	3
Lycodes sp.	—	—	—	—	—	—	1	—	—
Lumpenus lampetriformis	—	—	—	—	20	—	—	3	3
Clupea harengus (herring)	—	—	—	—	—	4	—	1	—
Mallotus villosus (capelin)	—	—	—	—	—	—	17	10	3

any definite conclusions on the food, the available records (Table IV) indicate a general similarity to the food in Scottish waters. Nevertheless, megrim of all sizes would appear to eat fewer crustaceans and more fish on these isolated banks. Sandeels, for example, are eaten more frequently (up to 33% in the

41-50 cm size group) than in the Scottish area, while *Gadus esmarkii* and other young or small gadoids continue to provide a substantial part of the megrim food on these banks.

Iceland

The food of megrim on Icelandic grounds shows no major differences from that in the regions already considered. Crustaceans would appear to be less frequently eaten by small megrim, just as on the oceanic banks, but, on the other hand, they appear to be eaten more frequently by the larger fish at Iceland than on any of the other grounds. Once more *Crangon* and *Pandalus* are the most favoured types, but it is interesting to note that Norway lobsters, *Nephrops norvegicus*, are eaten fairly often by both medium-sized and large megrim at Iceland, whereas the present investigations have revealed only one instance of megrim feeding on this animal in Scottish waters.

As on the oceanic banks, the smaller megrim at Iceland, in order to make up for the scarcity or absence of suitable crustacean food, or perhaps for their lack of interest in this type of food, appear to concentrate more strongly on post-larval and other young fish. Sandeels are eaten fairly frequently by all sizes, and capelin, which do not occur on the grounds already considered, are also eaten by a substantial proportion of the medium-sized and large megrim. As in the other regions, small gadoids, including *Gadus esmarkii*, again represent an important food item and flatfishes would seem to be eaten more frequently than elsewhere.

It is perhaps appropriate at this point to refer to numerous notes on the food of fish made on Scottish research vessels prior to the investigations described in this paper. These notes include observations on the stomach content of the megrim. Although this work was carried out at sea and, understandably, was not so detailed as food investigations in the laboratory, the results for the years 1933-1935, inclusive, are nevertheless interesting and are summarised in Table V. Apart from some slight differences

TABLE V

Identification of Megrim Food at Sea on Scottish Research Vessel

1933-1935

	North Sea					N & W of Scotland			
Size-group in cm	11-20	21-30	31-40	41-50	51-60	11-20	21-30	31-40	41-50
No. with recognisable food	18	87	104	41	6	7	54	69	18
No. feeding on:—									
CRUSTACEA	9	42	15	1	—	3	18	6	2
Crangon sp.	4	18	4	—	—	1	3	1	—
Pandalus sp.	1	10	7	1	—	—	14	5	1
Galathea sp.	1	—	—	—	—	—	—	—	—
Munida sp.	—	—	2	—	—	—	—	—	—
Eupagurus sp.	—	—	2	—	—	—	—	—	—
Euphausids	4	11	—	—	—	1	—	1	—
Isopods	—	—	—	—	—	1	1	—	—
CEPHALOPODA	—	1	1	—	—	—	2	1	—
PISCES	9	44	89	40	6	4	34	62	17
Post-larval fish	—	4	—	—	—	4	20	12	—
Sandeel	—	1	2	1	—	—	—	4	2
Gadus esmarkii	—	2	11	3	2	—	—	1	3
Haddock	—	—	—	—	—	—	1	—	—
Whiting	—	—	—	—	—	—	—	1	1
Urophycis blennoides	—	—	—	—	—	—	—	1	—
Common Dab	—	—	—	—	—	—	—	—	1
L. R. Dab	—	—	—	1	—	—	—	—	—
Callionymus lyra	—	1	1	—	—	—	—	—	—
Argentina sp.	—	—	1	—	—	—	—	—	—
Gobius sp.	—	—	1	—	—	—	—	—	—
Clupea sp.	—	—	—	—	—	1	—	—	—

n the proportions of megrim feeding on *Crustacea* these early results are in general agreement with the letailed work now being described.

VOLUMETRIC ANALYSIS OF THE STOMACH CONTENTS

The volumetric analysis of the megrim food is represented in Table VI. For comparison the quantities f the various constituents are expressed as percentages of the total stomach contents in each size-group nd in each region. Crustaceans and fish are again shown to be the predominant types in all regions,

TABLE VI

Volumetric Analysis of the Food of Megrim

Volumes of the main types Expressed as Percentages of the Total

		No. Stomachs examined	Total Volumes of Food cc	Volume of Crustacea cc	Volume of Fish cc	Volume of Mollusca cc	Volume of Polychaeta cc	Volume of Echinoderma cc	Volume of Unrecognisable material cc
ORTH SEA									
11-20 cm		264	73·0	40·2	25·6	6·8	—	0·1	0·3
	%			55	35	9	—	+	+
21-30 cm		846	737·3	139·6	569·7	25·9	+	—	2·1
	%			19	77	4	+	—	+
31-40 cm		803	1516·7	92·7	1385·9	34·6	0·1	—	3·0
	%			6	91	2	+	—	+
41-50 cm		288	1315·0	16·5	1280·3	17·8	0·1	—	0·3
	%			1	97	1	+	—	+
51-60 cm		33	388·4	1·0	387·4	—	—	—	—
	%			+	100	—	—	—	—
orth & West Scotland									
11-20 cm		75	21·2	12·4	7·5	0·2	+	—	0·1
	%			58	40	1	+	—	+
21-30 cm		371	283·9	78·9	201·2	1·9	1·2	—	0·7
	%			28	71	1	+	—	+
31-40 cm		473	766·1	69·3	691·3	4·2	—	—	1·3
	%			9	90	1	—	—	+
41-50 cm		213	982·2	19·5	933·7	29·0	+	—	—
	%			2	95	3	+	—	—
51-60 cm		13	51·8	—	51·8	—	—	—	—
	%			—	100	—	—	—	—
ceanic Banks									
11-20 cm		20	8·3	1·1	6·8	+	—	—	0·4
	%			13	82	+	—	—	5
21-30 cm		91	135·4	9·4	124·9	1·0	—	—	0·1
	%			7	92	1	—	—	+
31-40 cm		55	267·0	0·6	266·2	—	0·2	—	—
	%			+	100	—	+	—	—
41-50 cm		8	130·0	—	130·0	—	—	—	—
	%			—	100	—	—	—	—
eland									
11-20 cm		15	7·7	1·7	6·0	—	—	—	—
	%			22	77	—	—	—	—
21-30 cm		75	121·3	29·5	88·3	3·5	—	—	—
	%			24	73	3	—	—	—
31-40 cm		158	642·7	74·5	563·3	4·8	—	—	0·1
	%			11	88	1	—	—	+
41-50 cm		120	1160·0	91·4	1068·6	—	—	—	—
	%			8	92	—	—	—	—
51-60 cm		55	655·1	61·2	593·4	0·5	—	—	—
	%			9	91	+	—	—	—

olluscs forming a minor constituent in most size-groups. The combined volumes of polychaetes, echino-rms and other unrecognisable material rarely amounts to 1% of the total in any size-group or in any gion, and so may be conveniently disregarded in this analysis. The volume percentages of the three ain food types are illustrated in Figure 6.

Comparison of Figures 5 and 6 shows that despite the high proportion of the smaller megrim feeding t crustaceans the volume of the crustacean material in the stomachs is relatively small in the smaller

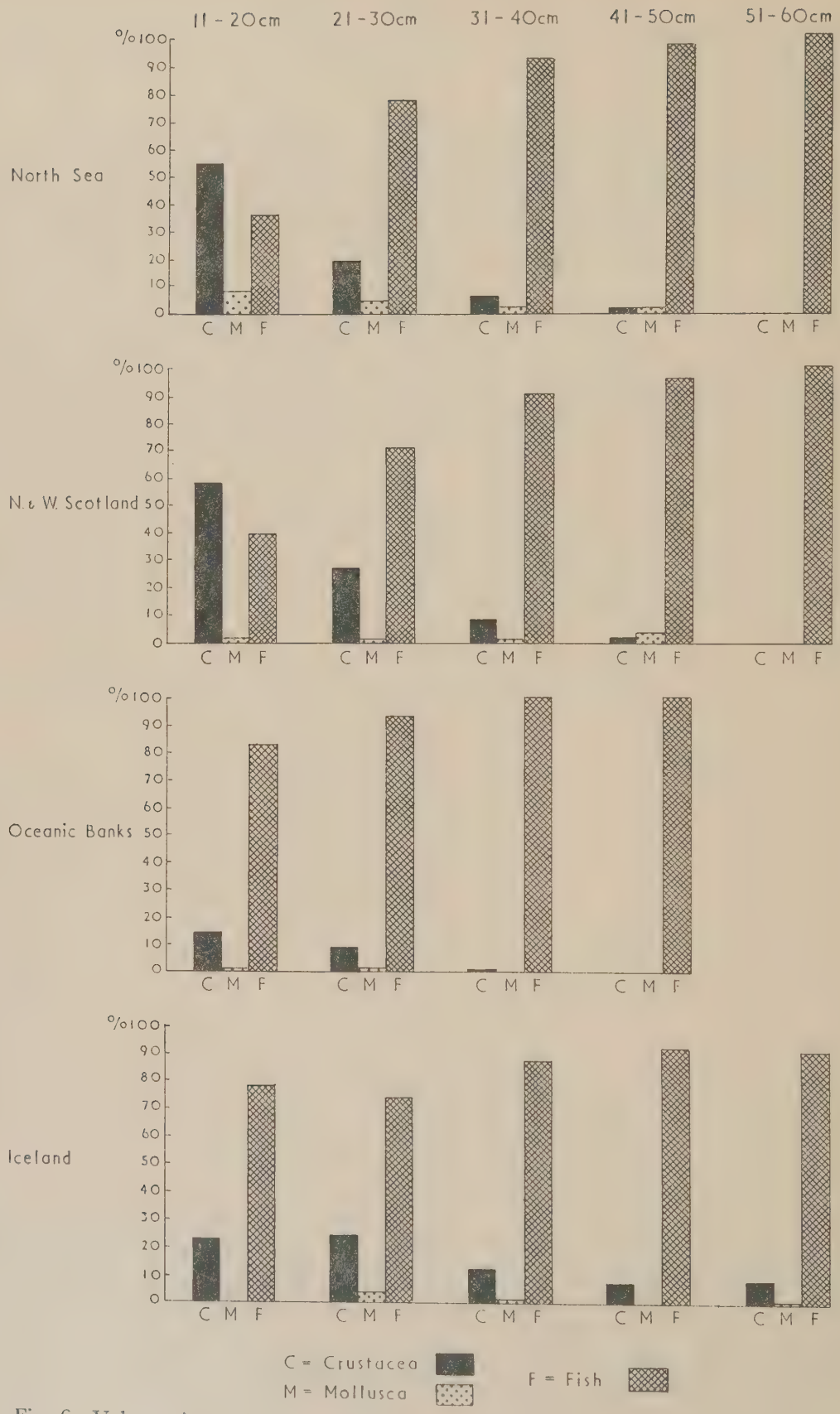

Fig. 6 Volumetric analysis of megrim food; quantities of the three main types expressed as percentages of the total stomach contents.

size-groups and in all regions, with the exception of the 11-20 cm size-group in the North Sea and off the north and west of Scotland. The volumetric analysis of the food stresses, therefore, the predominant importance of fish in the diet of the megrim.

DISCUSSION OF RESULTS AND COMPARISON WITH OTHER SPECIES

Feeding Habits

This investigation has shown that the intensity of feeding of the megrim varies throughout the year. The main feeding season is not so well defined in the megrim, however, as it is in the lemon sole (Rae, 1956), in which feeding is heaviest throughout the summer and lowest during the winter when, indeed, it ceases almost entirely in December. Although the principal feeding time for most megrims is also during the summer, the numbers of fish with food in their stomachs are never so high at this time as in the lemon sole; on the other hand they are never so low in winter. The reason for this is not clear, but the marked difference in the nature of the food may be partly responsible.

Some loss of the stomach contents of megrim undoubtedly occurs through regurgitation, when the fish are caught, as happens in some other species of fish, particularly those caught in deep water. Although no way of measuring this has been devised there is no evidence that it ever attains any great proportions or that it affects the proportions of fish found to be feeding at any time. Indeed, the remaining food in the stomachs, sometimes merely traces, is generally sufficient to show that the fish were feeding and to indicate the nature of the food. Regurgitation must, of course, affect the quantity of food in the stomachs so that the volumes of food per 100 stomachs (Table II) are almost certainly lower than they would have been if no loss of food had taken place. However, it may be assumed that the loss through regurgitation is more or less the same at all times of the year. Consequently the volumes in Table II, and in Figure 4 derived from it, may be regarded at least as relatively representative of the feeding intensity throughout the year.

While studying the food and feeding habits of the lemon sole, it was generally possible to dispel any doubts as to whether the fish were feeding or not by an examination of the state of the intestines. The lemon sole intestine during the feeding season is long and turgid and generally full of food, but during the off-feeding season, in December, the intestine contains no food and shrinks to but a fraction of its normal size. The megrim intestine, on the other hand, is short and at any time of the year rarely contains more than traces of food, and even that mostly mixed with a watery mucus. Material resistant to gastric fluids, such as crustacean claws and fish bones, was scarcely ever found in the megrim intestines, which seems to suggest that after leaving the stomach the digested food passes quickly through the intestine.

These differences would appear to be associated with the nature of the food and the feeding habits of the two species. The small-mouthed lemon sole eats relatively small organisms in which polychaete worms predominate. The large-mouthed megrim eats fewer and relatively large animals in which fish and decapod crustaceans are the predominant types. It would appear from the quantities of food in the stomachs that the lemon sole takes small quantities of food at frequent intervals, while the megrim takes relatively large quantities less frequently and perhaps less regularly.

The stomachs of megrim also appear capable of much greater distension than those of lemon soles. Occasionally they are stretched to many times their normal size by the ingestion of one or more gadoids. It is, moreover, characteristic of many megrims that they frequently devour fish, usually gadoids or sandeels, half as long as themselves. It seems likely, therefore, that this ability to consume relatively large quantities of food at any time may be a natural safeguard against irregular feeding and the possibility of having to go without food for some time.

Diurnal variations in the intensity of feeding of megrim were also studied but the evidence was inconclusive, although tending to suggest intermittent feeding throughout the 24 hour period.

Annual Feeding Cycle

From Tables I and II and Figures 3 and 4 it may be concluded that there are two periods of in tensive feeding in the annual cycle of the megrim. In the first of these, in March, the increase in th feeding is scarcely noticeable in the smallest megrim. It attains appreciable dimensions in the medium sized fish and reaches a considerable peak in the large fish. Moreover, in the large megrim this maximum not only extends into April but, on the basis of the present observations, also exceeds the second intensiv period during the summer, in magnitude. The second period, from June to September, is the principa feeding season for the small and medium-sized fish.

The annual feeding cycle of the megrim also includes two features which are common to all size groups. The first of these is the sharp decline in feeding following the spring outburst. This decline which is first evident in April and extends to the end of May, is scarcely noticeable in the smallest fish but is very conspicuous in the bigger fish.

The feeding of lemon soles, after increasing to a spring peak in April, declines, in a similar way, in May, before increasing again to its main maximum for all size-groups in the summer. Moreover, thi decline in May is, as in the megrim of 11-30 cm, scarcely noticeable in the smallest (11-20 cm) lemon soles. Because of this and because the smallest lemon soles are predominantly immature fish, it wa concluded that the decline in the feeding of the larger lemon soles in May was a result of the first wave of general spawning in that month.

From studies of the size and age of megrim (Furnestin, 1935; Rae, 1949) it seems reasonable to con clude that megrim of 11-30 cm are predominantly immature or adolescent fish, and that a high pro portion of fish in the 31-40 cm size group are adult fish which have spawned at least once; it is also reasonable to regard all megrim of 41 cm and over as adult fish. It seems possible, therefore, that the de cline in the feeding of medium-sized and large megrim is also related to the onset of spawning, which according to Schnakenbeck (1930), takes place from March to May. Furthermore, the rather longe delay in resuming feeding, apparent in the megrim, might possibly be due to the spawning period of th megrim in the North Sea being of shorter duration and consequently more concentrated than that o the lemon sole, in which spawning is prolonged from May to October (Rae, 1953).

The second feature of the megrim feeding cycle, common to all size-groups, is the very marke decline in feeding which occurs in October (see Figures 3 and 4). This decline is all the more surprisin because all sizes of fish appear to behave in the same manner and also to resume feeding more heavil in November and December. A possible explanation is a sudden scarcity of food, but this is scarcely born out by the increase in feeding in November. Another possibility is that some change may occur in th metabolism of the fish after the heavy feeding of the summer and autumn, but there is at present n evidence to support this. Yet another possible explanation is that a migration of larger fish (Fulton, 190 and the following paragraph) brings them to areas where food is more plentiful, and at the same tim relieves the pressure on the food supplies on their native grounds to the benefit of the smaller fish. From records of large megrim caught east of the Moray Firth and off the Aberdeenshire coast in winter there is indeed some slight evidence in support of this view.

While discussing these fluctuations in the feeding intensity of the megrim throughout the year, it is interesting to refer to fluctuations in the seasonal abundance of the species demonstrated by Fulton (1905) and referred to by Furnestin (1935). On the basis of catch per unit of fishing time Fulton found that the period of greatest abundance occurred from March to May, with its peak in April. Secondary maxima also occurred in September and December although these tended to be much less prominen and to vary regionally. Fulton concluded that the spring maximum was the result of the exploitation o the fish congregating for spawning. He also concluded from the megrim landings that, towards the end of the year, megrim moved from deep water nearer to coastal regions, although not actually into coastal waters, and that this to some extent accounted for the subsidiary peak landings in December.

The rough parallel in the seasonal feeding intensity and the seasonal abundance of megrim is intriguing. This certainly suggests that catches are heaviest during concentrations of fish for spawning and/or feeding purposes. However, it is impossible to comment on the significance of these results without a more detailed study of the problem, particularly an examination of the trend of the more recent landings of megrim under present day fishing conditions.

Composition of the Food

Early Investigations

The food of megrim has been dealt with briefly on four occasions in the past. Smith (1889, 1890) examined 12 fish from the Moray Firth and other Scottish east-coast grounds; of these five had empty stomachs, six were feeding on unidentified fish and one on *Crangon*.

Scott (1902) investigated the food of 31 megrims (size-range 11·5-20·0 cm) caught to the north of Shetland in May, 1901. The food consisted "almost entirely of *Crustacea* but it was in most cases very fragmentary". Euphausids were most in evidence but the genus and species could not be satisfactorily determined. The following were identified: *Erythrops serratus, Crangon allmani, Nika edulis, Ampelisca brevicornis* and annelid remains. In a medium-sized fish caught off Aberdeen Scott found *Sepiola* and *Crangon* remains.

Holt (1892) examined 112 megrims from grounds to the west of Ireland. Of 59 containing food 53 were feeding on fish and 14 on crustaceans, while one stomach contained cephalopod (*Sepiola*) and another annelid remains. The fish included sandeels, sprats, whiting, Norway pout, gobies, silvery pout (*Gadus argenteus*) and a young forkbeard.

Furnestin (1935) examined a number of megrim obtained from commercial catches on unknown grounds. Their food consisted of fish, crustaceans, molluscs, polychaete remains and *Ophiura*. The fish included sprats, sandeels, *Callionymus lyra*, Norway pout, whiting, and *Atherina presbyter*; the crustaceans *Pleoticus muelleri, Crangon allmani, Nika edulis, Eupagurus, Ampelisca brevicornis* and the molluscs *Dentalium, Sepiola* and *Cardium*.

Present Investigations

The results of these earlier investigations bear a close reesmblance to those described in this paper. Together they establish that the food of the megrim, over the greater part of the fish's distribution, consists predominantly of crustaceans and fish, with much smaller quantities of cephalopods and negligible amounts of polychaetes and echinoderms. Although Tables III and IV and the Appendix list a fairly large number of different animals in the diet of the megrim, the main types and the number of individual genera and species are in fact considerably fewer than those in comparable lists for other species of fish—for example, the plaice (Todd 1916; Ritchie 1938) and the lemon sole (Rae 1956).

The megrim is, therefore, much more restricted in its food than either of these other species. This restriction is even greater if one considers that the crustaceans are eaten largely by the smaller megrim and the fish by the larger megrim.

Even the crustaceans eaten by megrim are restricted to a few types or species. Thus euphausids, mysids etc, are mainly eaten by the youngest fish of up to 15 cm and natant decapods mainly by megrim of 16 to 35 cm. This dependence on natant forms suggests a definite mode of feeding—probably just off the sea floor. It is worth noting that most of the relatively few reptant decapods eaten are also able to swim or at least to dart through the water, for example, *Portunus, Galathea, Munida, Nephrops* and *Homolocaris*.

Although the euphausids and mysids found in the stomachs are in general too fragmentary to permit identification of the genus or species, except in a few instances, recognition has been more successful in the larger decapods. Although the appendix reveals at least 30 different decapod genera or species in the megrim food, Tables III and IV clearly show that the megrim depends to a very great extent on a few species. Thus *Crangon* and *Pandalus* of the natant decapods are eaten far more frequently than any of the others, and, again referring to the appendix, these are largely represented, at least in Scottish waters, by two species—*C. allmani* and *P. montagui*.

As indicated on p. 12 *Nephrops norvegicus* is eaten more frequently by large megrim at Iceland than in any other region. This may be partly owing to the rather higher proportion of big megrims of 51-60 cm in the stocks at Iceland, but on the same grounds *Nephrops* is also eaten by medium-sized megrim (Table IV). The single instance of a megrim feeding on *Nephrops* in Scottish waters in the present investigation was recorded from the Noup Deep, West of Orkney. Scottish research vessel records prior to 1938, however, include at least one other record from the edge of the Norwegian Deep in June 1927.

Similarly, among the fish food types, certain genera and species outnumber the others. Young gadoids, both numerically and volumetrically, form the most important individual sub-type. By far the commonest single species is *Gadus esmarkii*, although haddock and whiting are also well represented in the food of the larger megrim in certain localities. Sandeels also provide an appreciable part of the food of megrim of all sizes, reaching a maximum frequency of 33% in megrim of 31-40 cm on the Oceanic Banks. This high value was obtained very largely from samples procured on Faroe Bank where sandeels are particularly plentiful.

As Tables III and IV show, post-larval fish form an important item in the diet of the smaller size groups. Although this material is quickly digested in the megrim stomachs and identification is often difficult, it would appear, from those which have been recognised, that the post-larval types are on the whole the youngest stages of the fish commonly identified in the stomach contents—that is, sandeels, gadoids, long rough dabs, *Argentina* etc. It is noteworthy too that the three records of megrim eating megrim refer to the discovery of post-larval forms in the stomach contents.

Throughout these prolonged investigations from 1938 to 1960, only seven megrim were found to be feeding on herring. This observation might have passed without comment but for some records obtained prior to 1938. These early records include single fish feeding on herring from off Cape Wrath (YY16) in March 1924 and on the Viking Bank (G.20) in September 1926, 10 megrims of 20-46 cm feeding on small herring of 8-11 cm off Ronas Voe, Shetland, in September 1925, and 64 megrims of 21-58 cm feeding almost exclusively on small herring, 6-10 cm, off north-east Shetland, in August 1926. These results suggest that megrim may occasionally feed more extensively on herring than the present investigations indicate, possibly when young herring are plentiful on the grounds.

In a somewhat similar connection it is worth noting that all 28 records of capelin (*Mallotus villosus*) found in megrim stomachs at Iceland occurred in one month of one year, July 1958. The capelin migrate every year from northern to southern Icelandic waters, where it is preyed upon by different species of commercially important fish. It is clear that the megrim shares in this predation on the capelin shoals, thus lending further support to the view that at times it feeds intensively on particular species when they occur in concentration.

While considering the frequencies with which the various species of fish and crustaceans appear in the megrim food, it is important to remember that a high proportion of the material in the stomach cannot be identified other than as fish and crustaceans. It is reasonable, however, to assume that the indeterminate material may be apportioned to each of the constituent species in proportion to the frequency with which they have been observed to occur in the stomachs. In the same way those identified by a generic or group name such as *Crangon*, *Gadus* or flatfishes, may probably also be allocated to their constituent species. It follows, therefore, that the frequency values for each species are minimum values.

General Characteristics of the Food

Most of the species of fish eaten by megrim, whether post-larval or juvenile forms, such as sandeels, gadoids, argentines, young herring and capelin, have a common feature in their pelagic, or near-pelagic, habit, probably just above the sea floor. In this respect they resemble the natant decapods, euphausids and mysids on which they, as well as the megrim, prey. Even the single cephalopod which is eaten with any frequency, *Sepiola*, can be regarded as belonging to the same category. Purely sedentary forms have not been recorded in the analysis of the stomach contents, and of those animals having limited powers of movement, the few identified, such as *Dentalium*, *Ditrupa*, *Echinocyamus* and *Ophiura*, may well have been incidentally acquired through the stomachs of the fish eaten. The food of the megrim is thus characterised by its high degree of mobility, so that it seems logical to conclude that the megrim must pursue its food away from the sea floor. In this respect it resembles, to some extent, certain flatfishes such as the halibut and turbot, but differs in a marked way from others such as the plaice, lemon sole and witch.

The present data have also been examined for evidence of seasonal differences in the nature of the food in the various regions and localities. The results, however, give no clear indication that such differences exist and an intensive examination of the more densely populated areas would be desirable before any conclusive statement could be made on the subject.

OMPETITION FOR FOOD

Intra-specific and Inter-specific Competition

Consideration of the food of fish inevitably leads to the question of competition for the available ıpplies. It has already been observed that the harsher effects of intra-specific competition for the food 're, to a considerable extent, ameliorated in the megrim by a gradual changeover, firstly from crusta- ans to fish and secondly, from smaller crustaceans and fish to larger forms of the same or related ıimals.

It has also been shown that there is little resemblance between the food of megrims and that of rtain flatfishes commonly caught with them. There is, therefore, no competition for food between egrims and lemon soles and witches. Inter-specific competition, however, between those fish preying ı the animals most frequently eaten by megrims, certainly takes place. Thus, euphausids, mysids and pepods are eaten by the young forms of various species, including cod, and perhaps other big gadoids, ıd by adult forms of the smaller gadoids such as *Gadus esmarkii* (Raitt and Adams, 1962). To some tent the effects of this competition are lessened by the immense natural concentrations of these smal- r crustaceans, so that there would appear to be more or less enough for all. Competition also takes place r larger crustaceans such as the natant decapods between small and medium-sized megrim, young d of 21-40 cm, young halibut and young skate. Later, as they grow larger, megrim, halibut, cod ıd skate all change over gradually to a diet in which fish predominate. It would seem, therefore, that mpetition for the available food on any ground on which these fish occur together must be considerable. is not at all clear, however, that this competition actually is as great on the feeding grounds as it uld appear. Indeed, an examination of Scottish research vessel catches over the period of these in- stigations suggests that the harmful effect of competition may be much less than it seems. For example, grounds off north-east Shetland, where megrim and cod are among the commonest species taken, the aviest concentrations of megrim are clearly in the deeper water north of 60°45′N, while codling are ncentrated more in shallower water to the south of that latitude. The cod also has a much wider dis- bution throughout Scottish waters than the megrim and occurs in coastal waters such as the Moray rth and the Firth of Forth, where the megrim is far from common, and where the younger fish are deed extremely rare.

There is evidence, therefore, that although some inter-specific competition for food in the different ages of life undoubtedly occurs, the extent of this competition may not be so great as would appear m a mere knowledge of the food of the individual fish. Obviously the distribution of the various species ncerned (as determined by depth, physical conditions of the water, nature of the sea bottom etc.), the ological conditions in which they live and their seasonal movements and feeding habits must all be nsidered in any study of competition for the available food. Much more research remains to be done this interesting subject.

Industrial Fisheries

For many years now fisheries scientists have been concerned with the dangers of overfishing of the mmercially important food fishes. In recent years another type of fishery has developed—the dustrial fishery—in which emphasis is laid on the catching, not of the well-known food fishes but of aller species, some of which have until recently been of no commercial importance. These "industrial" ecies include sandeels and *Gadus esmarkii* which, as this paper shows, represent the principal food types the larger megrim. Since these species are also preyed upon by many other fish it may be that, if dustrial fishing continues, man may become in time a more serious competitor for sandeels and *Gadus markii* than other species of fish. Here too, however, further research is necessary to determine, among ner things, how many and to what extent commercially important fish are predators on sandeels and e smaller gadoids, and what the future effect of industrial fishing will be on the stocks of the small fish w being exploited.

SUMMARY

The intensity of feeding of the megrim varies throughout the year. In the youngest fish, feedin increases in the first three months, slackens off in April and then increases again to a maximum i September. The medium-sized and large fish show two feeding maxima—the first in March and th second from July to September, separated by a period of relatively light feeding in April and Ma Megrim of all sizes show a marked decline in feeding in October. In each size-group, too, this decline followed by a resumption of heavier feeding in November and December.

The food of the megrim consists predominantly of crustaceans and fish. The smallest fish feed mainl on crustaceans, but as they grow they gradually change over to a fish diet. The change-over is als characterised by a change from small crustaceans, euphausids etc. to larger forms such as natan decapods, and from small post-larval or juvenile fish to larger forms.

Although the list of different animals identified in the stomach contents of the megrim is fairl extensive, the bulk of the food consists of a few organisms including *Crangon*, *Pandalus*, *Ammodytes* an small gadoids.

The food and feeding habits of megrim are compared with those of other species. Attention is draw to the development of industrial fisheries which are largely dependent on *Ammodytes* and *Gadus esmarkii* two of the most important food items of the megrim.

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APPENDIX

LIST OF GENERA AND SPECIES IDENTIFIED IN THE FOOD OF MEGRIM. THE LOCALITIES WHERE EACH FOOD TYPE HAS BEEN FOUND ARE INDICATED BY THE STATISTICAL RECTANGLES, A16, C13 ETC. (SEE FIGS. 1 AND 2). RECTANGLES IN BRACKETS INDICATE RECORDS FROM SCOTTISH RESEARCH VESSEL OPERATIONS PRIOR TO 1938. REFERENCES IN BRACKETS INDICATE PREVIOUS RECORDS BY THE AUTHORITIES NAMED.

CRUSTACEA

Decapoda-Natantia

angon sp: A16, 17, 18; B14, 19, 20; C13, (15), 17, 18, 20, 21; D15, 17, 18, 19, 20, 21; E18, 19, 21; F18, 21; G17, 18, 21; H19; ZZ17; YY15, 16, 17, 18; XX (11), 12, 15, 16, 17; WW10, 11, 13, 15; VV10, 11, 12, 13; UU12, 13, 14; Faroe Bank; S.W. Faroe; Iceland FF26, HH25, JJ25, LL26; (Scott, 1902); (Holt, 1892).

angon allmani Kinahan: A17; B19; C12, 13, 16, 17, 20; D17, 19, 20, 21; E19, 21; F21; G17, 20; H19; ZZ17; YY16, 17, 18; XX12, 15, 16, 17; WW11, 16; VV14, 15; Faroe Bank; Iceland FF26, GG26, HH25, KK25; (Scott, 1902); (Furnestin, 1935).

angon vulgaris Fabricius: C20.

ndalus sp: A17; B19, 20; C (13), 18, 20, 21; D19, 20, 21; E19, 21; F19, 21; G18, 21; YY15, 16, 18; XX15, (16), 17; WW10, 11, 12; VV10, 15; Faroe Bank: S.W. Faroe; Iceland FF26, GG26, HH25, LL26, MM26.

ndalus montagui Leach: C13, 20: D18, 19, 20, 21; E21; YY15, 17; XX15; Faroe Bank; Iceland GG26.

ndalina (*Pandalus*) *brevirostris* (Rathke): D21; E21; F21; G17; YY17; 18; VV15.

ndalus bonnieri Caullery: G18.

ndalus borealis Krøyer: Iceland FF26.

ntophilus spinosus (Leach): A17; B19; C16, 21, D19, 20: VV14.

laemon (*Leander*) *serratus* (Pennant): (Furnestin, 1935).

erocrangon sp: F21; WW11.

ppolyte sp.: C13.

ka edulis Risso: C20, 21; D20, 21; E21; YY(16); XX16; (Scott, 1902); (Furnestin, 1935).

Decapoda-Reptantia

lathea sp.: C20, 21; D18, 20, 21; E21; F21; WW10, 16; VV10, 13; UU13.

lathea nexa Embleton: VV13.

unida sp.: B19, 20; C20, 21; D19, 20, 21; E21; F19; G17, 21; WW11; VV14; UU15; (Holt, 1892).

unida bamffica (Pennant): E21.

unida tenuimana G.O. Sars: D21; Iceland HH25.

unida rondeletti Mihi: VV11, 13.

locaris macandreae Mihi: E19; XX12; WW11, 12.

phrops norvegicus (L): A17; H(19); Iceland FF26, GG26, HH25.

pagurus sp.: C(20); D21; XX(17); (Furnestin, 1935).

tunus sp.: A17; C20, 21; D20, 21; E21; YY(16), 17; XX16, 17; VV14.

tunus holsatus Fabricius: A17; D20, 21.

tunus depurator (L.): D19.

tunus pusillus Leach: UU14.

lecyclus sp.: B20; C21; D21; VV14.

lecyclus heterodon Leach: C20; VV13.

lecyclus septemdentatus Montagui: VV14.

alia pennanti Leach: C20; D20.

Euphausiacea

ganyctiphanes norvegica (M. Sars): C21; D20; Iceland GG26; HH25, LL26.

ysanoessa sp.: VV13.

MYSIDACEA

Lophogaster typicus M. Sars: XX17.
Paramysis (Schistomysis) ornata (G. O. Sars): Rockall Bank.
Erythrops serratus G. O. Sars: (Scott, 1902).

AMPHIPODA

Ampelisca sp.: C20, 21; D20.
Ampelisca brevicornis (A. Costa): (Scott, 1902); (Furnestin, 1935).

ISOPODA

Cirolana borealis Lilljeborg: C21; D18; G21; WW11.

COPEPODA

Caligus sp.: E21.

MOLLUSCA

CEPHALOPODA

Sepiola sp.: C12, 20, 21; D19, 20, 21; E(19); XX15, 17; Iceland HH25; (Holt, 1892); (Scott, 1902); (Furnesti
1935).
Sepiola atlantica d'Orbigny: C16; D21.
Sepietta (Sepiola) oweniana (d'Orbigny): XX16.
Rossia sp.: D21; WW11.
Gonatus sp.: D20.

SCAPHOPODA

Dentalium sp.: D21; WW10; VV10; UU13; (Furnestin, 1935).

LAMELLIBRANCHIATA

Cardium sp.: (Furnestin, 1935).

POLYCHAETA

Ditrupa arietina (O. F. Müller): B19.

ECHINODERMATA

Echinocyamus pusillus (O. F. Müller): C20.
Ophiura sp.: (Furnestin, 1935).

PISCES

Ammodytes sp.: A16, (17); B19, 20; C18, 20, 21; D19, 20, 21; E(19), 21; ZZ17; YY(15), (17); VV14; UU1
Rockall Bank; Faroe Bank; W. Faroe; Iceland GG26, JJ25, LL26; (Holt, 1892).
Ammodytes tobianus L.: (Furnestin, 1935).
Gadus sp.: A16, 17; B17, 19; C13, 15, 16, 17, 21; D15, 18, 19, 20, 21; E19, 21; F18, 20, 21; G18, 21; YY1
XX15, 16, WW10, 11; VV11, 12, 13; UU13; Rockall Bank; Faroe Bank; Iceland FF26, GG26, HH2
JJ25, KK25.
Gadus esmarkii Nilsson: A15, 16, 17; B11, (20); C15, 16, 17, 18, 20, 21; D15, 18, 19, 20, 21; (E18), 19, (20), 2
F(15), 20, 21; G18, 19, 20, 21; YY15, (16); XX12, 15, 16, 17; WW10, 11, 12; VV14; UU13; Rocka
Bank; Faroe Bank; West Faroe; North Faroe; Iceland HH25, JJ25, LL26; (Holt, 1892) (Furnestin, 1935
Gadus aeglefinus L. D(18), 19, 20; E(19); F21; G21; YY(16); Rockall Bank; Iceland JJ25.
Gadus merlangus L.: B(20); C15, (17); D15, (18); YY(15), (16); Iceland JJ25; (Holt, 1892); (Furnestin, 1935).
Gadus callarias L.: D14.
Gadus minutus L.: C20; D20; XX15.
Gadus poutassou (Risso): B(20); Rockall Bank.
Gadiculus argenteus Guick: H17; VV(11); (Holt, 1892 = *Gadus argenteus*).
Urophycis blennoides (Brünnich): XX(15); (Holt, 1892).
Onos sp.: XX17.
Onos tricirratus (Bloch): WW11; Iceland LL26.
Hippoglossoides platessoides (Fabricius): A17; C13, 14, 15, 17; D18, 20, 21; F15, 21; WW13; Iceland FF26, GG26
HH25, KK25, LL26.
Limanda limanda (L.): A16; YY(16).

idorhombus whiff-iagonis (Walbaum): C20; E21; Iceland KK25.
ptocephalus cynoglossus (L.): E(19); YY(16).
ius sp.: C14, 15, 17, 20, 21; D20; E(19), 21; F21; YY(16), 17; (Holt, 1892).
ius minutus Gmelin: ZZ17.
ius pictus Malm: WW11.
lionymus sp.: A17; C20, 21; D20, 21; E21; ZZ17; XX12, 16; WW11; VV10.
lionymus lyra L.: D20; E(21); YY(16); WW10; VV13; (Furnestin, 1935).
entina sp.: C16, 20, 21; D18, 19, 20, 21; E19, 21; WW10, 11; UU14; Faroe Bank.
nus cataphractus (L.): D21; G18.
gla gurnardus L.: A17.
astes viviparus Kröyer: C21; D20.
penus lampetriformis (Walbaum): Iceland FF26, HH26, LL26.
des sp: Iceland HH25.
asfer dentatus Cuvier: C21; E21; Iceland LL26.
erina presbyter Cuvier: (Furnestin, 1935).
bea harengus L.: B(20); D17, (20); E19; F21; G(20), 21; YY(16); VV(14); Iceland HH25.
bea sprattus L.: (Holt, 1892); (Furnestin, 1935).
llotus villosus (O. F. Müller): south-west Iceland.

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